International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 8.141
Peer Reviewed Bi-Monthly
Vol. 7 No. 5 January – February - 2026

A GIS and AI- Based Study of Beach Morphology and Sediment Characteristics of Budhal Beach, Ratanagiri District, Maharashtra

Miss. Diksha Sugriv Gaikwad

Assistant Professor, Department of Geography, Sharadchandra Pawar Mahavidyalaya, Lonanad,

DOI - 10.5281/zenodo.18899092

Abstract:

Beach is a usually defined as an accumulation of unconsolidated sediment like Boulder, Cobble, Pebble, Granule, Sand, Silt, Clay etc. extending from the mean low-tide line to the area where physiography changes or where permanent vegetation changes. Morphodynamics is the study of the evolution of landscapes and seascapes in response to the erosion and deposition of sediment. Beach morphology refers to the interaction and adjustment of the seafloor topography and hydrodynamic processes. Hydrodynamic processes include wave action, tides and winds. Morphodynamics processes consist positive and negative feedbacks. Several properties of the sediments are important in coastal engineering. Most of these properties can be placed into one of three: the size of the particles making up the sediments the composition of the sediments or the characteristic of the sediments mass. As sediments approach the beach, it gains maturity. Sediments are less mature in alluvial fan region & more mature in beach. The maturity of sediments depends upon the distance it covers. The more the distance it covers, the more it is sorted. From the grain size distribution, various parameters, mean grain size, sorting, skewness & kurtosis etc. were obtained. The beach in this area is subject to active erosional processes. Beach sediments are carried out by waves and water from the inlet, exposing pebbles. Data Analysis with help of Artificial Intelligence.

Keywords – Morphodynamics, hydrodynamic, Wave action.

Introduction:

Beaches have a complex nature in the coastal environment. Beaches and headlands are features that represent erosion and deposition. In the coastal system, beaches are significant and play a crucial role. Beaches are important in research because they help us to understand geomorphic processes. Beach sediments are dynamic part of the coastal region. The study of beach sediments and morphology provides valuable information about the beach environment. Beach sediments are mix of a range of grain sizes. In general wind transports sediment to the upper part of the beach, while tides, currents, and waves transport sediment to the swash zone and nearshore region. Textural analysis of sediments has fascinated coastal researchers, and to investigate potential information about transport mechanisms and size sorting processes of sediments in several environments, this study is important.

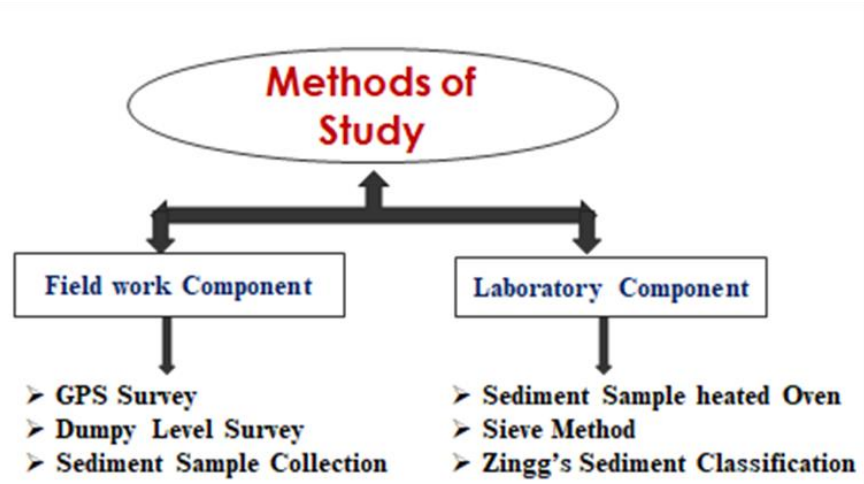
Significance of Study:

The sediment transport mechanisms on sandy beaches are more complex. Because of the powerful forces of tides and winds, erosion activity becomes dominant. Beach dynamics can help us understand land-sea interactions. Beach morphology analysis provides valuable information about the beach system. This study is important to understand beach morphology, transport mechanisms, depositional activity, and

textural characteristics of sediments. It is helpful for beach management. The study explains the grain size characteristics, shape and size analysis of course sediment and beach morphology of Budhal beach. The aim of this work is to investigate and study the sediment characteristics of Budhal beach. The study explains the grain size characteristics, shape and size analysis of coarse sediment and beach morphology of Budhal beach.

Aims and Objective:

1. To Study and Analysis of sediment characteristics of Budhal Beach
2. To study the morphology of Budhal beach.
3. To Study the Wave Refraction of Budhal Beach.



Software used For Work

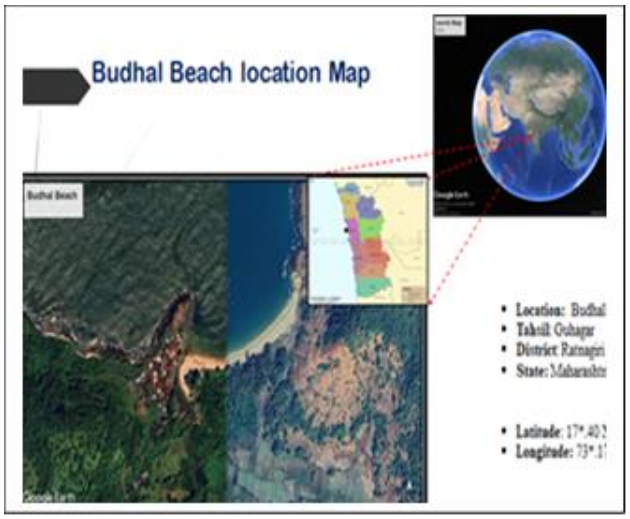
- Global Mapper
- Artificial Intelligence
- Surfer
- Arc GIS
- Google Earth Pro
- MS Office

Data Sources

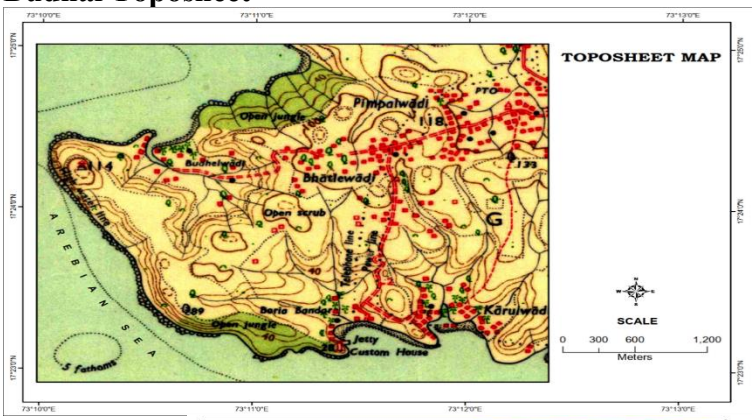
- Toposheet : 47G/3
- Google Earth Image
- Sediment Data
- GPS Survey

Study Area:

The location site selected for present work is Budhal Beach. It is a sandy beach on the West coast of India. The beach covers a half-kilometer stretch with varying width about 40-55m. It is located along the coastal stretch of Guhagar Taluka in Ratnagiri District in Maharashtra. Budhal beach is a north-facing sandy beach. A small settlement, Budhelwadi, is located on the west side of the beach. It is a remote and very clean beach. It is about a half-kilometer-long beach with sand and clean water. This beach is composed of sand, seashell fragments, a small quantity of pebbles, and rocks. On the west section, there is an inlet. **Location:** Budhal Beach, Guhagar Tahsil, Ratnagiri District, Maharashtra.

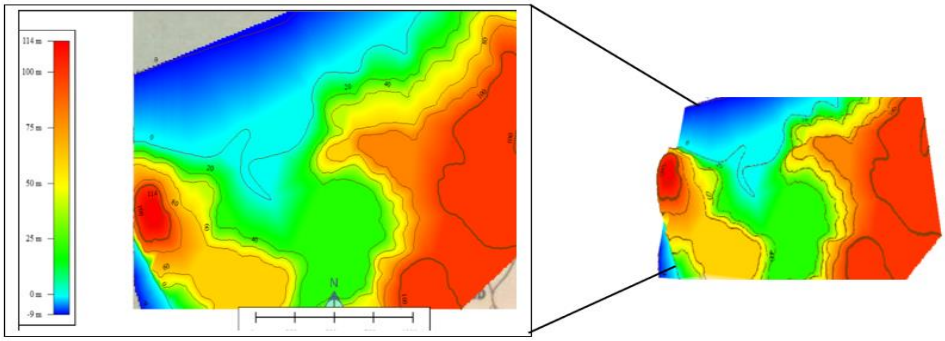


Budhal Toposheet



- **SOI Toposheet no:**

  47 G/3
- **1st Edition Year:**1977
- **Scale:** 1:50000



Digital Elevation Model of Budhal Beach **3D Digital Model**

Sediment Characteristics:

Grain size distribution by sieve analysis is very helpful to understand transport dynamics and classifying sedimentary environments. The texture of sediment deals with its size and shape. By description, comparison, and interpretation, textural analysis takes place. Sediment properties were represented using sediment samples that were taken in December 2021. The weather was calm, there was no rain, and the sky was typically clear. Sediment depicts the seasonal quiet climate qualities of the winter. Along the Budhal beach, 27 samples were collected for textural analysis. Core tubes and a hammer were used to collect samples. Nine samples were collected at backshore (BS), nine at foreshore (IS), and nine at shoreline (FS) sites. To get rid of the moisture, each sample was dried in oven. On a mechanical shaker, each sample was mechanically sieved. According to sieve size sediments are characterized.

Sediment Sample Collection Points Along the Budhal Beach

Composition of Budhal Beach Sediments:

To understand the composition of different categories of sediments, such as granule, very coarse sand, medium and coarse sand, fine sand, very fine sand and silt, fine sand, very fine sand and silt sediment sample weight percentage method is used. The composition of beach sediments along Budhal beach varies more in the west section than in the east section.

Sediment Composition in %

Sr. No.	Profile	Sediment Sample Code	Latitude (DD)	Longitude (DD)	Granule	Very Coarse Sand	Medium & Coarse Sand	Fine Sand	Very Fine Sand	Silt
1	1	BUD P1 BS	17.40820278	73.17876667	0.17	0.03	60.56	38.90	0.32	0.02
2		BUD P1 IS	17.40818333	73.17866389	0.11	0.43	78.13	21.21	0.10	0.02
3		BUD P1 FS	17.40817778	73.17850833	2.63	2.16	77.36	17.46	0.30	0.09
4	2	BUD P2 BS	17.40769722	73.178625	2.58	1.93	80.77	14.36	0.28	0.07
5		BUD P2 IS	17.40769444	73.17854444	0.03	0.35	86.10	13.38	0.09	0.05
6		BUD P2 FS	17.40775556	73.17837222	17.28	16.37	63.53	2.73	0.05	0.04
7	3	BUD P3 BS	17.40732778	73.17844722	0.50	0.12	47.37	49.67	2.24	0.10
8		BUD P3 IS	17.407475	73.17828333	0.64	1.97	74.47	22.59	0.29	0.04
9		BUD P3 FS	17.40758056	73.17814167	19.87	12.17	48.24	18.69	0.84	0.18
10	4	BUD P4 BS	17.40688333	73.17780833	3.30	2.55	50.94	41.25	1.85	0.11
11		BUD P4 IS	17.40703889	73.17769167	0.36	1.07	64.46	33.07	0.87	0.18
12		BUD P4 FS	17.40719444	73.17758333	2.08	3.67	69.17	23.09	1.95	0.04
13	5	BUD P5 BS	17.40653611	73.176975	0.76	5.75	70.63	21.63	1.13	0.11
14		BUD P5 IS	17.40664167	73.17692778	0.80	4.29	72.73	20.93	1.05	0.20
15		BUD P5 FS	17.40678333	73.17685833	46.39	26.00	20.63	6.44	0.50	0.03
16	6	BUD P6 BS	17.40641944	73.17645278	0.22	0.25	56.49	40.16	2.78	0.10
17		BUD P6 IS	17.40653333	73.17645	1.62	2.91	59.91	32.51	2.70	0.35
18		BUD P6 FS	17.40666667	73.17641389	34.18	24.26	26.06	12.75	2.44	0.32
19	7	BUD P7 BS	17.40641389	73.17599722	0.06	0.45	59.84	36.87	2.60	0.19
20		BUD P7 IS	17.40653889	73.176	1.11	1.16	54.24	40.26	3.07	0.15
21		BUD P7 FS	17.40665833	73.17606389	15.81	54.97	28.56	0.62	0.04	0.00
22	8	BUD P8 BS	17.40641667	73.17563056	0.21	0.17	43.06	52.12	4.19	0.25
23		BUD P8 IS	17.40657778	73.17563611	5.26	7.73	54.05	29.51	3.22	0.23
24		BUD P8 FS	17.406725	73.17569167	19.17	31.53	31.69	16.71	0.58	0.32
25	9	BUD P9 BS	17.40643056	73.17514444	4.72	2.29	53.78	34.10	4.87	0.23
26		BUD P9 IS	17.40665833	73.17523333	9.63	8.05	53.84	24.75	2.99	0.75
27		BUD P9 FS	17.40684444	73.17535	22.11	11.62	49.23	13.96	2.81	0.26

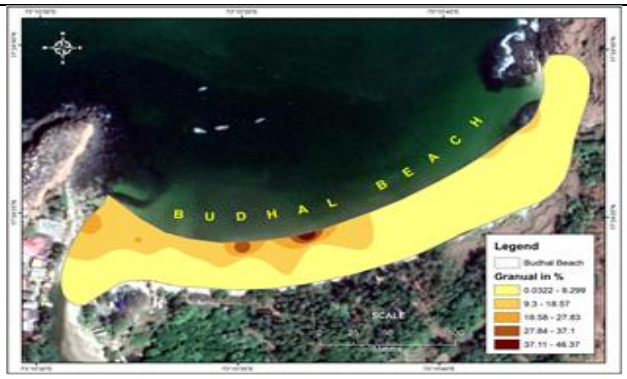
(Source: Compiled by the researcher)

Granule

- Grain diameter more than 2mm
- Average granule percentage is 7.83 %.
- Backshore 1.3 %
- Shoreline 18 %

West part beachfront has greater granule composition.

Pebbles, cobbles, granules are found here.



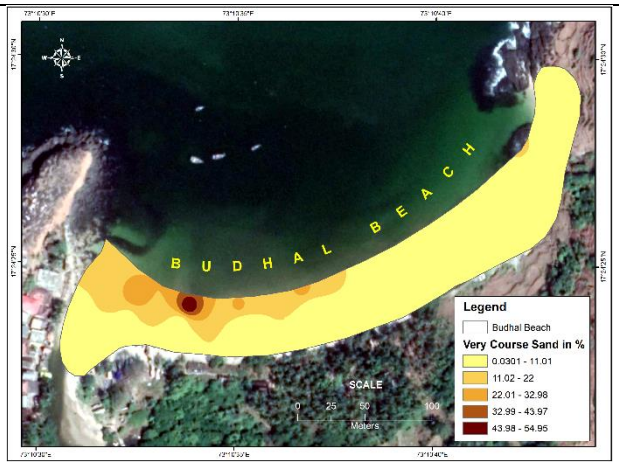
Very Coarse Sand

Grain diameter 1mm to 2mm

The Budhal beach has average percentage of very coarse

- sand 8.3 %.
- Backshore 1.5%
- Shoreline 20.3%

The very coarse sand along west section shoreline is higher than its east section beachfront. Larger diameter granules and very coarse sand are present in the area due to erosional processes.

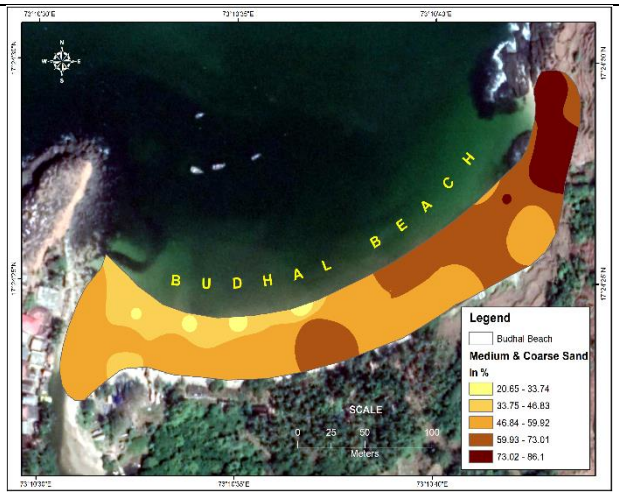


Medium & Coarse Sand

Grain diameter 0.25mm to 1mm

- The average percentage of medium and coarse
- sand is 56.88 %.
- Backshore 58.16%
- Shoreline 46.05 %

Medium and coarse sand predominates in the sediment composition along Budhal beach, accounting for approx. 56.8 % of the total.

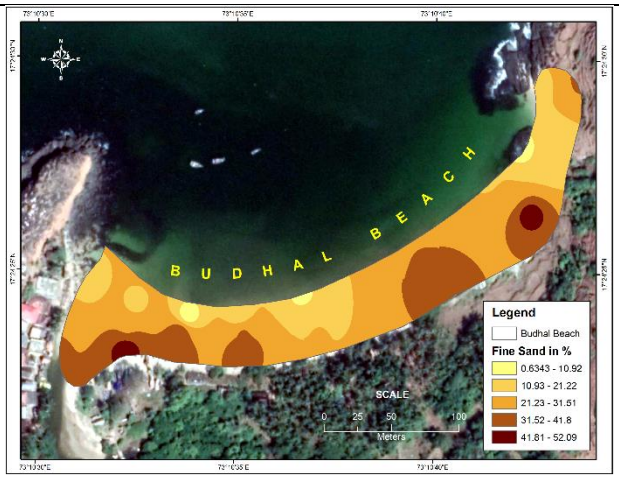


Fine Sand

Grain diameter 0.25mm to 0.125mm

- The average percentage of fine sand along Budhal beach is 25.17 %.
- Backshore 36.56%
- Shoreline 12.4 %

The backshore of beach has a higher percentage of fine sand. Less fine sand is present in sediments with a higher granule fraction. On the beach, where erosional activity occurs, there is less fine sand composition.

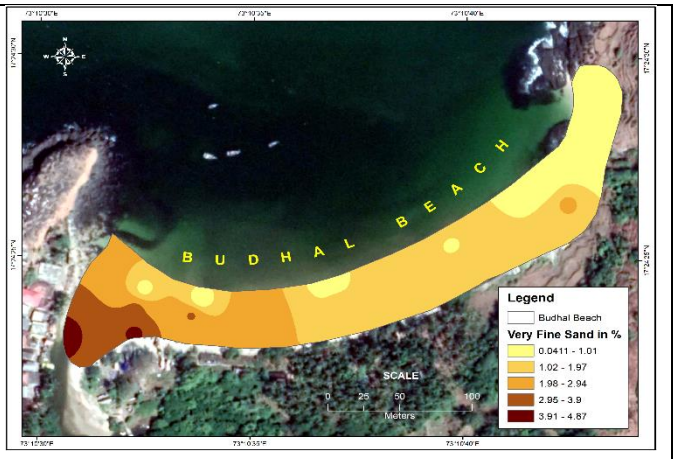


Very Fine Sand

Grain diameter 0.125mm to 0.53mm

- The Budhal beach's average very fine sand Percentage is 1.36 %.
- Backshore 2.25 %
- Shoreline 1.05 %

The backshore has a higher percentage of very fine sand than the Budhal beach shoreline.



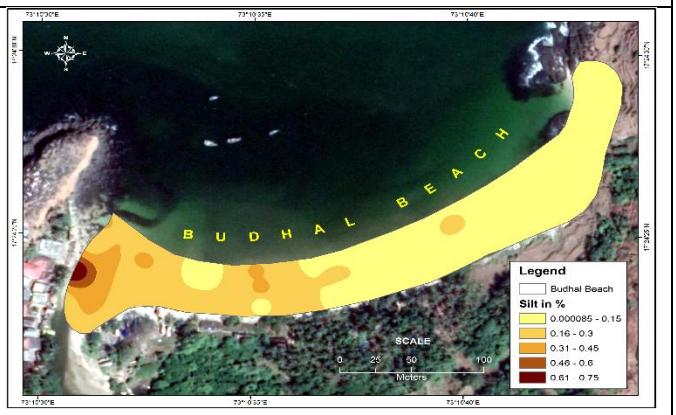
Silt

Grain diameter smaller than 0.053mm

The Budhal beach has an average

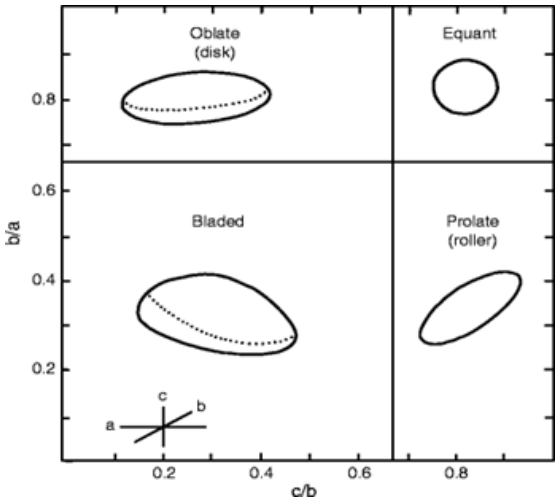
- Silt percentage of 0.26 %.
- Backshore 0.13 %
- Shoreline 0.21 %

Silt composition is higher in sediment where tidal inlet deposits occur. Because of deposition, the west section of the beach has more silt in its sediments than the east section



Zingg's Classification for pebble's shape:

To study the shape of pebbles on Budhal beach, Zingg's (1935) classification is used. Zingg's classification is the easiest and most logical way to estimate pebble shape. For the analysis, pebbles were collected from 2 points along the Budhal beach. Budhal is a sandy beach, but the west side of the beach has an exposed pebble bed.

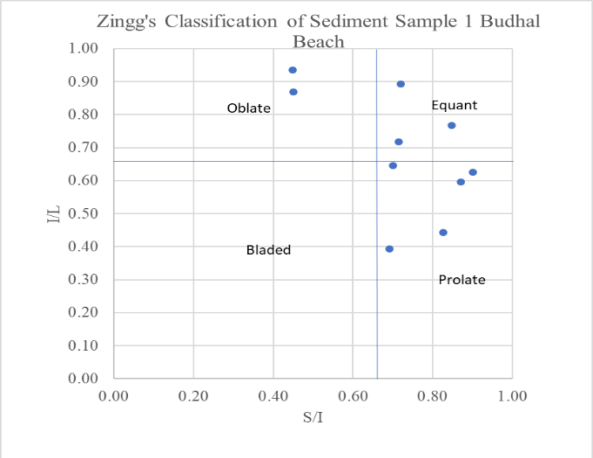


Criteria Table for Zingg's Classification

Sediment Shape	I/L or b/a	S/I or c/a
Spheroidal (equiaxial)	>2/3 or >0.67	>2/3 or >0.67
Discoidal (Oblate)	>2/3 or >0.67	<2/3 or <0.67
Rod (Prolate)	<2/3 or <0.67	>2/3 or >0.67
Bladed (Triaxial)	<2/3 or <0.67	2/<3 or <0.67

Zingg's Classification of Coarse Sediment Sample 1

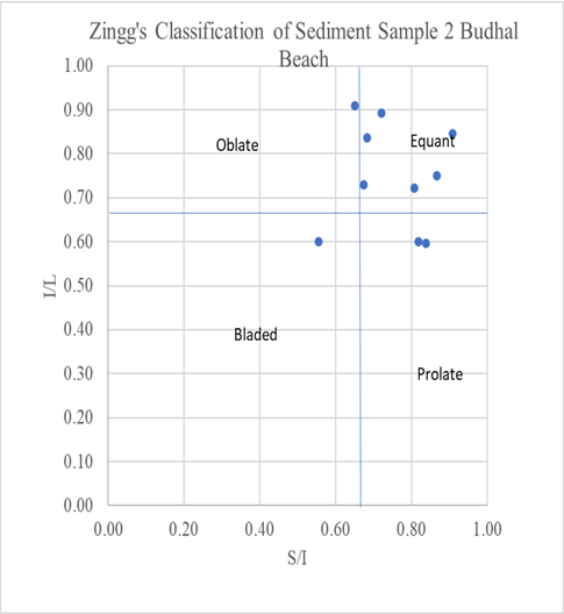
Sediment No.	L (cm)	I (cm)	S (cm)	S/I (X axis)	I/L (Y axis)	Shape
1	2	1.5	1.3	0.87	0.75	Equant
2	2.6	2.2	2	0.91	0.85	Equant
3	2.8	2.5	1.8	0.72	0.89	Equant
4	3.6	2.6	2.1	0.81	0.72	Equant
5	4.4	4	2.6	0.65	0.91	Oblate
6	3	1.8	1	0.56	0.60	Bladed
7	4.9	4.1	2.8	0.68	0.84	Equant
8	5.5	3.3	2.7	0.82	0.60	Prolate
9	5.9	4.3	2.9	0.67	0.73	Equant
10	6.2	3.7	3.1	0.84	0.60	Prolate



Prolate shaped sediments predominate in this sample, accounting for 50% of total sediments. Equant sediments account for 30% of the total, while oblate sediments account for 20%. There are no bladed sediments

Zingg's Classification of Coarse Sediment Sample 2

Sediment No.	L (cm)	I (cm)	S (cm)	S/I (X axis)	I/L (Y axis)	Shape
1	6.2	3.7	3.1	0.84	0.60	Prolate
2	5.9	4.3	2.9	0.67	0.73	Equant
3	5.5	3.3	2.7	0.82	0.60	Prolate
4	4.9	4.1	2.8	0.68	0.84	Equant
5	3	1.8	1	0.56	0.60	Bladed
6	4.4	4	2.6	0.65	0.91	Oblate
7	3.6	2.6	2.1	0.81	0.72	Equant
8	2.8	2.5	1.8	0.72	0.89	Equant
9	2.6	2.2	2	0.91	0.85	Equant
10	2	1.5	1.3	0.87	0.75	Equant

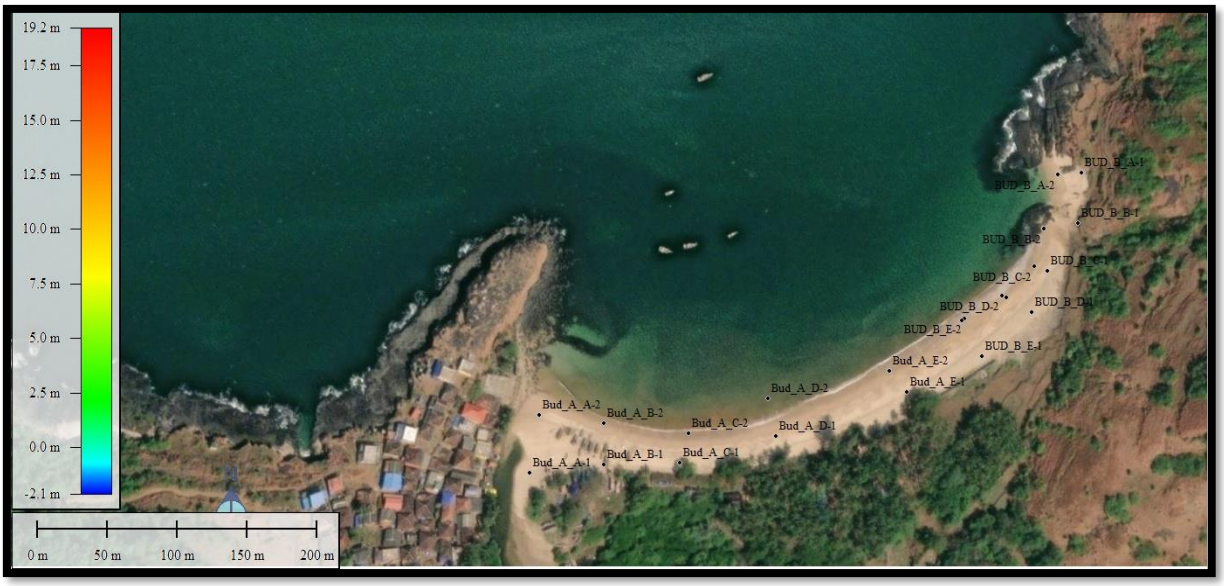


Sediment sample includes **60% Equant** shape sediments. By 20%, these Equant shape sediments are followed by **Prolate** sediments.

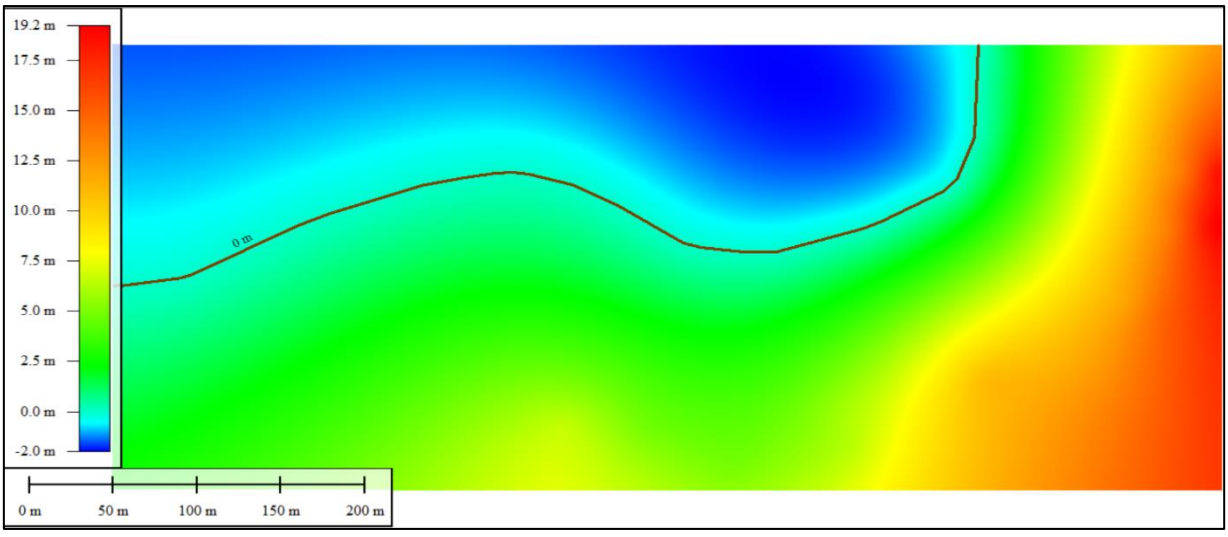
Oblate and bladed sediments account for 10% of the total. Oblate and bladed sediments account for 10% of all transported sediments.

DUMPY LEVEL GPS SURVEY READING (2023)

CODE		LONG	LAT	ELEV_ASTER	CODE	BS	IS	FS	BM	HI	RL
A_A-1	BS	73.17519	17.40633	7.289	A_A-1	0.7			7.289	7.989	7.28
A_A-2		73.17525	17.40668	6.669				1.76			6.22
A_B-1	BS	73.17566	17.40638	6.129	A_B-1	0.36			6.129	6.489	6.12
A_B-2		73.17567	17.40663	4.939				1.82			4.66
A_C-1	BS	73.17615	17.40639	5.022	A_C-1	0.4			5.022	5.422	5.02
_A_C-2		73.17621	17.40657	4.593				2.01			3.41
A_D-1	BS	73.17677	17.40655	6.288	A_D-1	1.06			6.288	7.348	6.28
A_D-2		73.17672	17.40678	5.862				1.83			5.51
A_E-1	BS	73.17761	17.40682	11.233	A_E-1	0.86			11.233	12.093	11.23
A_E-2			17.40695	11.108				1.75			10.34
B_A-1	BS	73.17873	17.40816	18.588	B_A-1	0.8			18.588	19.388	18.58
B_A-2			17.40815	14.242				1.56			17.82
B_B-1	BS	73.17871	17.40785	19.178	B_B-1	0.68			19.178	19.858	19.17
_B_B-2		73.17849	17.40782	13.848				1.69			18.16
B_C-1	BS	73.17851	17.40756	15.102	B_C-1	1.37			15.102	16.472	15.10
B_C-2		73.17843	17.40759	13.847				1.79			14.68
B_D-1	BS		17.40731	14.547	B_D-1	1.02			14.547	15.567	14.54
B_D-2		73.17822	17.40741	11.751			1.24				14.32
B_D-3		73.17825	17.4074	11.956				1.93			13.63
B_E-1	BS	73.17809	17.40704	12.197	B_E-1	0.83			12.197	13.027	12.19
B_E-2		73.17798	17.40727	10.781			1.1				11.92
B_E-3		73.17796	17.40726	10.696				1.89			11.13

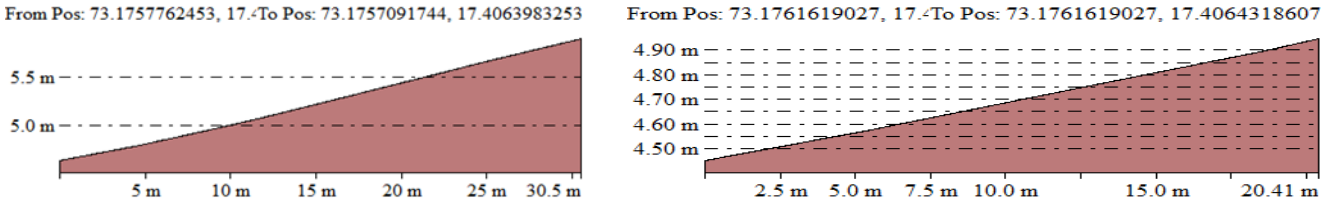


DUMPY LEVEL GPS SURVEY READING (2023)



Budhal Beach (0 Meter Contour

Beach Profiles



Morphology Of Budhal Beach:

- Sediment Deposition Area: 0.02083 sqkm
- Length of Beach: 492.06 m concave shape seashore
- Average Width: 40 m
- Average Slope: 3.1°
- Deposition Range: 0.8 m to 4 m

  Deposition is greater in the east section. The slope gradient in the west section is greatly influenced by the tidal inlet. Budhal beach's average slope is 3.1°, indicating that it has a gentle slope and fine sand.

Conclusions:

- Budhal Beach is a sandy beach. Sediment deposition seems to be the dominant process than active erosional processes. The beach in this area is subject to active erosional processes. Beach sediments are carried out by waves and water from the inlet, exposing pebbles. The sand layer is thin, and there is a heterogeneous material composed of pebbles, cobbles, and large boulders. Oblate, Equant, and Prolate shape sediments predominate in western end of beach.
- In general, it can be concluded that active erosional processes dominate on Budhal beach in the west region of the beach. Waves and water from the inlet transport fine sand and silt. The west region of the beach has prolate and equant shaped cobbles, according to Zingg's classification. Oblate and bladed sediments are the least common.
- The main peculiarity of this beach is it is north facing beach and it is controlled by wave and tide, hydrodynamics along with currents. Process responsible for the modification of the beach morphology pertaining to transport beach material is controlled by tides, tidal range and wave dynamics.

References:

1. Savindra Singh – Physical Geomorphology- Prayag Pustak Bhavan, Allahabad.
2. Shete Kavita – "Geoinformatics Approach for the Geo-environmental study of coastal area" – A case study of Kolthare Environs, Dapoli , Tahshil, Dist. Ratnagiri, Maharashtra.
3. Coastal Geomorphology (S. Karlekar)
4. Barnali Das – " Morphodynamics of sediment characteristics of beach" – A case study of Thambewadi beach, Dapoli Taluka, Dist. Ratnagiri, Mahrashtra.
5. Pratik Kokate – "Beach Morphology of Budhal Beach, Guhagar Tahsil, Ratnagiri District, Maharashtra".
6. https://manoa.hawaii.edu/exploringourfluidearth/physical/coastal-interactions/wave-coast-interactions.
7. Use of Artificial Intelligence